SB
193
.G9

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 117.

B. T. GALLOWAY, *Chief of Bureau.*

THE RESEEDING OF DEPLETED RANGE AND NATIVE PASTURES.

BY

DAVID GRIFFITHS,

ASSISTANT AGRICULTURIST, FARM MANAGEMENT INVESTIGATIONS.

ISSUED DECEMBER 13, 1907.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1907.

LIBRARY OF CONGRESS

Monograph

SHOUT
SHARE
IT

Class SB 193

Book G9

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF PLANT INDUSTRY—BULLETIN NO. 117.

B. T. GALLOWAY, *Chief of Bureau.*

THE RESEEDING OF DEPLETED RANGE AND NATIVE PASTURES.

BY

DAVID GRIFFITHS.

ASSISTANT AGRICULTURIST, FARM MANAGEMENT INVESTIGATIONS.

ISSUED DECEMBER 13, 1907.

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1907.

BUREAU OF PLANT INDUSTRY.

Pathologist and Physiologist, and Chief of Bureau, Beverly T. Galloway.
Pathologist and Physiologist, and Assistant Chief of Bureau, Albert F. Woods.
Laboratory of Plant Pathology, Erwin F. Smith, Pathologist in Charge.
Investigations of Diseases of Fruits, Merton B. Waite, Pathologist in Charge.
Laboratory of Forest Pathology, Haven Metcalf, Pathologist in Charge.
Plant Life History Investigations, Walter T. Swingle, Physiologist in Charge.
Cotton and Tobacco Breeding Investigations, Archibald D. Shamel, Physiologist in Charge.
Corn Investigations, Charles P. Hartley, Physiologist in Charge.
Alkali and Drought Resistant Plant Breeding Investigations, Thomas H. Kearney, Physiologist in Charge.
Soil Bacteriology and Water Purification Investigations, Karl F. Kellerman, Physiologist in Charge.
Bionomic Investigations of Tropical and Subtropical Plants, Orator F. Cook, Bionomist in Charge.
Drug and Poisonous Plant Investigations and Tea Culture Investigations, Rodney H. True, Physiologist in Charge.
Physical Laboratory, Lyman J. Briggs, Physicist in Charge
Crop Technology Investigations, Nathan A. Cobb, Expert in Charge.
Taxonomic Investigations, Frederick V. Coville, Botanist in Charge.
Farm Management Investigations, William J. Spillman, Agriculturist in Charge.
Grain Investigations, Mark A. Carleton, Cerealist in Charge.
Arlington Experimental Farm, Lee C. Corbett, Horticulturist in Charge.
Sugar Beet Investigations, Charles O. Townsend, Pathologist in Charge.
Western Agricultural Extension Investigations, Carl S. Scofield, Agriculturist in Charge.
Dry Land Agriculture Investigations, E. Channing Chilcott, Agriculturist in Charge.
Pomological Collections, Gustavus B. Brackett, Pomologist in Charge.
Field Investigations in Pomology, William A. Taylor and G. Harold Powell, Pomologists in Charge.
Experimental Gardens and Grounds, Edward M. Byrnes, Superintendent.
Vegetable Testing Gardens, William W. Tracy, sr., Superintendent.
Seed and Plant Introduction, David Fairchild, Agricultural Explorer in Charge.
Forage Crop Investigations, Charles V. Piper, Agrostologist in Charge.
Seed Laboratory, Edgar Brown, Botanist in Charge.
Grain Standardization, John D. Shanahan, Expert in Charge.
Subtropical Laboratory and Garden, Miami, Fla., Ernst A. Bessey, Pathologist in Charge.
Plant Introduction Garden, Chico, Cal., August Mayer, Expert in Charge.
South Texas Garden, Brownsville, Tex., Edward C. Green, Pomologist in Charge.
Cotton Culture Farms, Seaman A. Knapp, Lake Charles, La., Special Agent in Charge.

Editor, J. E. Rockwell.
Chief Clerk, James E. Jones.

Farm Management Investigations.

W. J. Spillman, *Agriculturist in Charge.*

Scientific Staff.—F. G. Allison, Harmon Benton, D. A. Brodie, L. E. Carrier, J. S. Cates, J. S. Cotton, M. A. Crosby, L. G. Dodge, E. J. Glasson, David Griffiths, Byron Hunter, C. K. McClelland, H. B. McClure, R. A. Oakley, W. A. Peck, C. E. Quinn, S. M. Tracy, C. W. Warburton, J. A. Warren, J. M. Westgate.

DEC 1907
D. of D.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 20, 1907.

Sir: I have the honor to transmit herewith, and to recommend for publication as Bulletin No. 117 of the series of this Bureau, the accompanying manuscript entitled "The Reseeding of Depleted Range and Native Pastures," by Dr. David Griffiths, Assistant Agriculturist, Farm Management Investigations.

This paper embodies the results of successful experiments in the reseeding of native pastures and points out the character of the regions wherein success may be expected from the use of seed followed by little or no cultivation.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

	Page.
Introduction	7
Popular conceptions of reseeding ranges	7
Results accomplished	8
Native species	8
Cultivated species	11
Introduced weedy species	15
Character of seeding dependent upon nature of region	17
Burning native pastures	18
Cultivation	19
Weeds in native pastures	21
Summary	22
Description of plates	24
Index	25

ILLUSTRATIONS.

Page.

PLATE I. Improved and unimproved native meadows in northeastern California. Fig. 1.—Timothy and redtop established without cultivation. Fig. 2.—An unimproved valley similar to that shown in figure 1 24

II. Central California ranges. Fig. 1.—A sedgy, weedy mountain meadow where timothy and redtop will succeed. Fig. 2.—Foothills where introduced brome-grasses have taken possession 24

III. Native pastures in Kansas and Arizona. Fig. 1.—A native pasture in central Kansas where Kentucky bluegrass is gradually taking possession. Fig. 2.—A native pasture in Arizona during a favorable season 24

B. P. I.—313.

THE RESEEDING OF DEPLETED RANGE AND NATIVE PASTURES

INTRODUCTION.

The most frequent inquiries referring to range management and improvement relate to the reseeding of native pastures which have been reduced in productiveness by neglect and mismanagement. The following pages, based upon observations and investigations covering a period of ten years, give only a brief summary of information. The subject is important to the entire country, for native or seminative pastures are common even in thickly settled communities of the East; but the discussion herein relates primarily to what was once the great free-grass country west of the Missouri River, which even in its most thickly settled areas still produces much forage upon virgin soil.

POPULAR CONCEPTIONS OF RESEEDING RANGES.

The very subject of reseeding presupposes a lack of cultivation or other artificial means of increasing feed production. It is often difficult to draw a distinction between native and tame pastures, for when any improvement is made in an artificial way through tillage or reseeding the pasture becomes a tame pasture in proportion to the tillage and seed used. For the purposes of this discussion a liberal interpretation is adopted to permit a discussion of any grade of pasture up to a thoroughly tilled one of tame grasses.

The opinion is prevalent in range sections that any improvement in native pastures ought to be and must be made by simply sowing seed and giving it no attention other than to pasture the crop that it produces. In other words, that a grass, a shrub, or some other forage plant should be found which when scattered among native vegetation will supplant that vegetation, at least in part. It is expected that plants may be introduced which will be better adapted to the prevailing conditions than those which have found lodgment there and managed to develop, continually becoming better adapted to the surrounding environment through past centuries. While such an accomplishment is not at all impossible, the chances are

many to one against success in such a venture. Plants introduced through seeding and allowed to shift for themselves seldom succeed, and success is attained in such cases only when they have particular characteristics and are placed under peculiarly suitable conditions.

RESULTS ACCOMPLISHED.

The State agricultural experiment stations located in the stock-range sections, some independently and some in cooperation with the Department of Agriculture, have given much thought and attention to the feature of range improvement by reseeding in all its phases. The Department alone in a single year gathered and distributed nearly four tons of seed of native grasses, which was mostly used in experiments in the improvement of native pasture lands. A large quantity of seed of cultivated varieties of forage plants has been employed also, and various grades of cultivation, ranging from simply scattering seed to nearly thorough cultivation, have been resorted to. These lines of work have extended over a period of ten years or more with profitable results.

NATIVE SPECIES.

There is logic in the supposition that species growing under given conditions are better adapted to those conditions than introduced species and that they will thrive better when encouraged by scattering and by partially covering their seeds than introduced kinds until conditions are more or less changed. These changes may be brought about by the destruction of the native vegetation, by overgrazing, by thorough cultivation, or by any other means which interferes with the natural order of the development of the plants. In other words, when forage plants are introduced it is usually necessary to give them special care in order that they may be able to compete with native species. This applies to practically all cultivated crops. There are certain notable exceptions to this general rule in certain special natural conditions, and it is these exceptions that are of especial interest.

Acting upon the suggestion that the native species are best adapted to the natural conditions in which they are found, much time was spent by the State agricultural experiment stations and by the Department of Agriculture a few years ago in experimenting with the reseeding of native pastures with native species. Large quantities of native seed were gathered and planted under various conditions.

There are many difficulties in the way of improving native pastures by the use of seed of native species, the chief obstacle being the difficulty of securing the required seed. Many, possibly the

majority, of our best native species of forage plants have such poor seed habits that it is difficult to reduce the expense of gathering them to an economic basis. There is usually no trouble in getting small quantities of seed and in growing the plants in conventional grass-garden plots upon an experimental basis and under thorough cultivation, but this is a very different thing from the reseeding of native pastures, with little or no cultivation.

Another obstacle is the difficulty of judging the seasons properly. Seed is more likely to be collected during a favorable season when the crop is good, and it is then sown in the following year. The next season after a favorable one is more than likely not to be favorable for seed germination. The fact is commonly lost sight of that, although one is placing the seed of native species under conditions more or less similar to those found in nature, when one gathers and sows seed upon uncultivated soil the chances are against its success. The likelihood of seed of perennial species of grasses growing under natural conditions is very small as a usual thing; and it is the perennials that are most valuable. To maintain a perennial species it is necessary for its seed to grow but seldom. Then when it is considered that many species propagate vegetatively we recognize how uncertain the chances are for reproduction from seed sown unless the soil receives some artificial treatment in the shape of cultivation for the subjugation of competing native plants. Our best cultivated pasture grasses to-day are Kentucky bluegrass for the North and Bermuda grass for the South. But the propagation of these grasses from seed is far from satisfactory, for under the most favorable range conditions it would take at least three or four years to thoroughly establish bluegrass. It is difficult in the first place to procure the seed of native species; in the second place, the seed obtained is often of poor germinating quality, because many of the plants habitually get along without the use of seed, which they produce imperfectly; and, in the third place, it is difficult to sow the seed at the proper season, for in the arid West it is only in favorable seasons that conditions are suitable for seed germination. It may therefore happen that seed failing to germinate would have been successful if sown in a more favorable season. It will be readily perceived, therefore, why the list of native forage plants which have been successfully used, even on a small scale, in the renovation of native pastures is small, although there are many species, no doubt, that can be domesticated when serious attention is devoted to the subject.

Upon the eastern slope of the Black Hills of South Dakota some farmers have improved their meadows by sowing seed of western wheat-grass (*Agropyron occidentale*) which they collected from their hay crops. Here, however, in the main, good results are secured by

irrigation. Water is commonly applied to raw prairie land, which in a short time, if the drainage is proper, will produce good crops of this grass to the exclusion of almost everything else. The grama grasses, especially, under this treatment disappear very rapidly before this species, which propagates by creeping rootstocks. Too much water or improper drainage, on the other hand, causes this western wheat-grass to be replaced in turn by rushes (*Juncus* spp.) and sedges (*Carex* spp.), as is the case in many areas of Montana and Wyoming. This is especially noticeable in certain cities of South Dakota where artesian water is employed in excess upon lawns of native grasses.

Something may be done with western wheat-grass in a small way to improve native pastures in some of the western prairie States if the seed is covered by harrowing and careful attention is paid to seeding in favorable seasons only. It is next to useless to sow without any cultivation, and with cultivation the expense would be prohibitive except on a small scale where labor can be used for the work in slack times when not needed for other purposes, and even then it is quite probable that greater returns would be secured by placing the ground in a thorough state of cultivation and seeding to some well-tried tame grass.

Bunch-grass (*Agropyron spicatum*) has been used successfully on a small scale upon denuded pastures in eastern Washington, but at almost prohibitive expense. Lands in this section once well stocked with this species recuperate slowly under protection from overgrazing, even without artificial seeding.

A closely related species (*Elymus triticoides*) generally inhabits the low, moist, nonalkaline bottoms in the Great Basin country, but also extends into the interior valleys of California. Several unsuccessful attempts have been made to use this species, but the writer considers all of the experiments known to him ill advised. This grass is adapted to low bottoms which receive at least one flooding each year. Its seed habits are first class, and it resembles western wheat-grass in both habit and general appearance. In many localities in northeastern Nevada and southeastern Oregon this grass has spread to sagebrush land and produced good crops under the influence of partial irrigation in the shape of a single diversion of spring flood waters on the lower sagebrush areas along the grassy bottoms. This species and *Poa lucida* vie with each other for supremacy under such treatment.

A number of ranchers in the Rocky Mountain and Great Basin regions have recorded successful attempts at growing giant rye-grass (*Elymus condensatus*). The seed habits of this grass are good, but it is very coarse, and consequently in sections where there is a liberal supply of finer and less fibrous feeds it is not in favor. It is stoutly

maintained by ranchers in some sections that stock will not eat it, but the common experience of stockmen shows that cattle eat what they have to eat. In many sections it is a highly-prized species and is often cut for hay. It is very tenacious when thoroughly established and will grow in soil which is quite alkaline.

The list of native species which have been successfully used in reseeding or increasing the feed upon the range with a minimum of artificial treatment is small and confined almost entirely to the wheat and rye grasses previously mentioned.

CULTIVATED SPECIES.

There are a few species of cultivated forage plants which have been introduced successfully for the restoration and improvement of native pastures and meadows. In mountain meadows redtop (*Agrostis alba*) and timothy (*Phleum pratense*) are without doubt the most important. (See Pl. I, figs. 1 and 2.) There are many localities, especially in the Rocky Mountain and the coast ranges, where native sedgy and weedy vegetation has been very largely replaced by the judicious use of seed of these grasses. Remarkably good stands of both were to be seen in the Kootenai Mountains of Montana as early as 1897. These had been established by one or two seedings in late autumn with no cultivation whatever. Experiments in which the Department of Agriculture was interested conducted in 1897 with timothy in the Big Horn Mountains of Wyoming were successful in producing a decided increase in the yield of pastures at an altitude of 7,000 feet and also in creek bottoms at an altitude of 4,500 feet.

The experience of some of the most successful live-stock owners in the United States furnishes ample proof of the value of redtop and timothy in moist situations. Both with partial tillage and with no tillage these men have successfully sown seed in quantities of a ton upon moist meadows around Steins Mountains in eastern Oregon.

Some of the meadows established around the edges of the sinks above the alkaline soils by scattering the seed of redtop and timothy upon lands subsequently irrigated by spring flood waters have produced excellent permanent pastures of these two grasses, with little or no cultivation. In some cases where the grasses have been established along the upper courses of draws and creeks the seed has subsequently been slowly washed down the valley, producing gradually a decided change in the meadows of the creek bottoms. Throughout the Rocky Mountain region especially these two grasses are widely scattered, having become disseminated from hay and other horse feed hauled into the mountains, as well as by systematic effort. It is generally well understood that these grasses are most promising for reseeding ranges, and many ranchers have made more or less systematic attempts to introduce them upon private holdings.

In addition to these, red clover, white clover, and orchard grass have been used successfully in a more limited way in mountain meadows and upon cleared woodlands.

Fall planting will without doubt prove most advantageous in such situations on account of the difficulty of reaching the meadows early in the spring, as well as on account of the nature of the soil. It is a very noticeable fact that the ground dries out rapidly after the snows disappear in the spring in all the mountains of the extreme West and Southwest. The soil is very coarse and loose, and consequently dries out quickly. Sometimes the surface soil a few feet from a melting snowdrift is too dry for seed germination. Fall planting will then be most successful, for it will utilize the moisture to the greatest possible extent, causing the seed to germinate over the widest area possible. Care must be exercised to plant late in the autumn so that no germination will take place until spring. Seeding on the early snows is often a good practice, for then the seed, especially if it be timothy or alsike clover, is carried into the ground sufficiently to be covered. Redtop ought to be brushed or lightly harrowed, for its seeds do not cover as easily and are more likely to be blown away by the wind or to be washed away by the flood waters.

The methods employed in introducing these grasses into mountain meadows vary greatly. Sometimes the seed is scattered upon the snow; at other times it is sown in autumn on comparatively dry ground or in the spring upon wet ground as the snow melts. The efficiency of the different methods will depend largely upon the locality and the moisture conditions. On the whole, late fall seeding will prove most successful when no cultivation is practiced. Early spring sowing will, however, give good results if the ground remains moist enough for seed germination until the plants can become established. A great deal depends upon the altitude of the meadows to be seeded and the character of the soils of which they are composed. Harrowing with brush or with a spike-tooth harrow can usually be resorted to with profit, but further cultivation must be done with good judgment if the topography and soil are such that erosion is likely to occur. Good results have been secured from all methods. Even when sown upon sedgy meadows with no cultivation, timothy and redtop especially often supplant the native vegetation in very large measure, but usually the more sedgy portions remain permanently and the introduced grasses obtain control of the edges of the meadows in the more loose friable soils commonly found close to the willows, the redtop becoming more prevalent in the more moist situations.

Indeed, the willow lands in mountain meadows are well adapted to the growth of timothy. There are considerable areas which could be very much improved in the quality of their feed if shrubby willows were

removed and timothy and redtop sown. The soil in these situations is always loose, porous, and rich in humus, and is moist the greater part of the year, furnishing good conditions for the growth of these grasses. The growth of timothy upon willow lands, with little or no cultivation, is successfully carried on in the Okonogan Valley of Washington. Here it is a common practice to grub out the willow thickets and scatter timothy seed with no further preparation of the soil than to remove the willow stumps and leave the ground as smooth as possible. In two or three years with proper care a good timothy hay meadow is obtained. The same treatment would transform many mountain willow areas into much improved pastures or meadows.

The fact that the areas are subjected to inundations in the spring is not always prohibitive, for timothy withstands cold running water very well. Instances have come under the observation of the writer in eastern Oregon where timothy meadows have been flooded with shallow running water in the spring for a period of two weeks without apparent injury.

Any work upon the extension of mountain meadows by the removal of the brush about the edges must be done with rare judgment and care, for the conditions are such that the temporary destruction of the brush cover of these areas will often lead to erosive action that will destroy the entire meadow. This is especially true of many of the small meadows of the Sierra Mountains of California, where considerable work has been done by the Department of Agriculture. (See Pl. II, fig. 1.) Here it would be hazardous to destroy even the sedge turf, for it is underlain by a soil that erodes easily. In many cases plowing would result in an erosion that would drain and completely destroy the meadow. Supplanting the sedgy vegetation, which is of less value, by easily introduced species which will furnish more feed with little or no cultivation is to be recommended in such situations.

Redtop is of more importance in many places than timothy. It has the advantage of being adapted to moist situations. It is often difficult to determine whether a given meadow is better adapted to timothy or to redtop without a complete seasonal knowledge of the locality where the experiment is to be tried. Usually in every meadow some areas are better adapted to one than the other, and consequently the use of both in the improvement of native meadows is to be recommended.

Redtop commonly does not make a showing as soon as timothy, but it lasts longer and gradually drives out the latter on all soils to which it is adapted. Its ability to extend its distribution by means of running rootstocks gives it an advantage. Of course it is not to be expected that either of these grasses will produce immediate

results when sown among native vegetation in this way without cultivation. The results come gradually. It is really a remarkable thing that cultivated plants should be able to compete at all with native vegetation in its native habitat. Redtop is more difficult to establish than timothy, mainly because of the difference in their seeds, the seeds of the latter being more easily covered than those of the former. Covering the seed is much more important with redtop than with timothy. If no cultivation is given redtop should be sown in the fall just before the first snows come, and this is probably the best time, all things considered, for timothy seeding as well. This is doubtless the surest way to get the seed into the ground sufficiently for germination to take place. Owing to the difficulty of judging accurately the areas which are best adapted to each crop, it is advisable to sow a mixture of timothy and redtop. The first will make a showing earlier than the latter, but, especially in the moister situations, will eventually be supplanted by it.

Kentucky bluegrass (*Poa pratensis*), a distinctive pasture grass, is exceedingly aggressive and is adapted to and is becoming firmly established in the eastern edge of the cattle country. It is working westward into the western plains region. (See Pl. III, fig. 1.) Its spread is due to no intentional assistance from man, but it is spreading, nevertheless, very rapidly under the grazing conditions obtaining in this region. The indications now are that all of the small draws and ravines of native pastures far into western Kansas and Nebraska will eventually be largely taken by this grass without any assistance. Farther east, in the brushy regions of Arkansas and Missouri, it spreads rapidly under the influence of such grazing as will keep in check the more aggressive native grasses and brush, and indeed is now the main pasture grass over large sections of this region, so firmly has it become established.

It is entirely practicable to assist the spread of Kentucky bluegrass by seeding it upon uncultivated land. It should not be expected to furnish full stands in a short time. Indeed, it will take two, three, or four years to get a stand in favorable regions, and a proportionally longer time in other situations where the conditions of rainfall are less favorable. On the whole, fall seeding will probably give the best results, and light harrowing with a fine-tooth harrow will add to the success obtained. When there is sufficient rainfall in autumn to germinate the seed it will be profitable to sow then, if it can be done early enough to allow the grass time to become thoroughly established before the ground freezes; if not, then it should be seeded too late in the fall for germination during that season. In the western prairie States when it is desirable to supplant the native vegetation by bluegrass, the attempts should be first made in favored localities in creek

and river bottoms and in draws and ravines where the lands are heavier and the moisture more abundant than upon the uplands. In central Kansas and Nebraska, and especially eastward, conditions are more favorable for success on the uplands still used for pasture purposes.

On the whole, some of the standard forage plants mentioned have produced more permanent benefit in the improvement of native pastures and meadows than either of the other two classes. Their application, however, is limited to the conditions described.

INTRODUCED WEEDY SPECIES.

In certain sections of the United States aggressive annual plants have supplanted in a great measure the native vegetation and now furnish a large part of the feed on the uncultivated lands. Striking examples are found over large areas of California and Arizona and in the Columbia basin where the introduced plants are often much more abundant than the natives.

It is a noticeable fact, however, that all of these introductions were purely accidental. All of the annual introduced weedy plants which are so prominent and many of which are so important from a forage standpoint in the floras of the regions mentioned have been introduced without conscious effort, although by the agency of man.

Most prominent among these is alfilerilla, which is supposed to have been introduced from the Mediterranean region of Europe, but which apparently finds a more congenial home in America than in its original habitat. It is now found in both high and low altitudes of western America from the Canadian border to the hotter regions of southern Mexico. It is only in limited localities, however, that it has gained prominence. The conditions necessary for its best development appear to be mild, moist winter weather. Such conditions are furnished in portions of California especially. In southern Arizona the winters are mild enough, but the moisture is often lacking or improperly distributed, so that the crops produced fluctuate greatly. In some seasons small crops of hay of this plant may be cut in favorable desert areas, but usually it furnishes but indifferent grazing. The crop of the spring of 1906 was the heaviest ever known. Its range of adaptability is shown by the fact that it matures in April upon the levels of the Salt River valley, while it may not mature until June upon the higher levels of the Colorado slope of the San Francisco Mountains. (See Pl. III, fig. 2.)

No experiments yet conducted have been successful in introducing alfilerilla upon the ranges and having it care for itself and spread with any degree of rapidity, although many attempts have been made. Seedings made in the Santa Rita Mountains in the summer of 1906

germinated quite well the following winter, the first time, it is believed, that even this much has been definitely accomplished. The plant has, however, been spread apparently by sheep, and some ranchmen have made systematic efforts to spread it by methods of grazing, but there is very little, if any, definite knowledge at present as to the best way to handle the plant. The probability is that if seed is secured and scattered before a favorable season, success may be had in spreading it. The main consideration is to scatter the seed before a season favorable to its germination.

Wild oats (*Avena* spp.), of which there are two species of importance in California, forms, with alfilerilla, the most important feed in many sections. Like alfilerilla, little success has been had in attempts to spread either of the species on the range, although one of them occurs in abundance in cultivated lands in many sections of the United States and in other parts of the world. One of the species is sometimes found in the Huachuca, Santa Catalina, and other mountains of southern Arizona. Seed sown in the Santa Rita Mountains germinated in the winter of 1907 for the first time, although it was sown there on several previous occasions. Seeding with this grass will succeed better when it is covered with a harrow.

Besides the grasses previously mentioned there is a group of bromegrasses (*Bromus* spp.) which have become exceedingly abundant in the Pacific coast country. These species furnish, on the whole, rather poor feed, but on account of their aggressiveness they are of a great deal of importance. The feed is of low grade for several reasons. These grasses mature in early summer and like nearly all annuals are of low nutritive value after maturity. The seeds of some species are very annoying to stock, especially sheep, and even when young, green, and succulent, the plants are pulled up by the roots and are consequently not easily grazed by stock. These bromegrasses have invaded the coast territory by the assistance of man, but in spite of his conscious intentions. While they furnish considerable feed, it is not only of an inferior quality, but some of the species cause considerable direct injury through crowding out plants of more value. (See Pl. II, fig. 2.) The shepherd has to remove his flocks from the tucolote (*Bromus maximus*) areas of California when the seeds ripen, on account of the injury done to the feet, mouths, and eyes of his flocks by the sharp-pointed seeds of these grasses. On the whole, it is doubtful whether the introduction of this species has not been a positive detriment to the stock interests of California. The crowding out of other plants and the injury done to stock in many cases at least more than counterbalance the value of the feed produced by it. In the same category with tucolote may be mentioned wall-barley (*Hordeum murinum*) which, when

properly handled, makes a fair quality of hay and pasture, but is troublesome in meadows if allowed to mature before being cut.

To this group of aggressive weedy annuals belongs the Russian thistle, which is such a menace in the prairie States upon cultivated lands. In portions of the Southwest, especially along the Santa Fe Railway in New Mexico and Arizona, it is spreading rapidly. While it is pernicious in the cultivated plains regions mentioned, it adds somewhat to the forage supply and probably interferes very little with valuable native species in the arid regions of small forage production.

CHARACTER OF SEEDING DEPENDENT UPON NATURE OF REGION.

To one who is familiar with the range country in general there are evident principles involved which can not but be recognized as fundamental in introductions of grasses of the kind considered in these pages.

The introduced plants which have become conspicuous upon uncultivated sodded lands of this country are much less numerous than those which have become established upon unsodded lands. The plants which establish themselves in each section differ very radically in their habits of growth.

The only introduced forage plant which has become at all conspicuous and aggressive in the prairie States in competition with the native plants is Kentucky bluegrass, which is a perennial and spreads of its own accord by running rootstocks rather than by seed. The plants which have become established in the unsodded, uncultivated Southwest and in the Columbia Basin are annuals requiring but a short period of growth for their development and having good seed habits. The Russian thistle, some of the mustards (*Sisymbrium* spp. and *Brassica* spp.), and other weeds are well established in cultivated fields, but they do not compete at all with native species. They persist in neglected fields and upon the prairies to some extent, but only in gopher knolls and other partially cultivated situations. They do not compete with the native vegetation on untouched prairie soils. On the other hand, no introduced perennials have become established and aggressive upon the unsodded soils of the Southwestern States. The nearest approach to their establishment is in the case of Bermuda grass (*Cynodon dactylon*) and Johnson grass (*Sorghum halapense*), but they become conspicuous only in favored localities and mostly in cultivated or partially cultivated fields and moist situations which are capable of being, if not actually, sodded.

It seems, therefore, that the plants which have the best chances of becoming established without cultivation in the unsodded southwestern soils are what are termed weedy annuals with good seed

habits. As illustrations may be mentioned those which have become conspicuous over large areas, such as the brome-grasses, wild oats, and alfilerilla. The chances of introducing plants which will become aggressive on uncultivated sodded lands are much less than on unsodded areas.

The two types of regions discussed in these pages are so entirely different in their vegetative characteristics that it is difficult even to compare them. One has normally a ground cover with a thick mat of plant roots in the greater part of the surface soil, while the other is very largely devoid of vegetation. During a portion of the year in the latter situations the vegetation is less dense and usually occurs in scattering bunches when perennial, with considerable vacant space between; and when annual it produces a very irregular crop, which grows only in favorable situations in normal years. The regions which are largely devoid of vegetation, it would seem, are better adapted to the growth of annual plants whose seeds may fall upon unoccupied areas and by their special contrivances for planting themselves become incorporated with the soil without the interference of grass and other roots which occur in a sodded region.

Again, the unsodded Southwest, unlike the sodded northern plains, has different relations between its seasons of moisture and heat. The moist winter seasons here admit plants which will grow at comparatively low temperatures. The moisture is of such short duration that plants must pass through the vegetative state and mature seed in a comparatively short time, or else they will be destroyed by the following drought. Ordinary herbaceous plants (valuable under grazing) are therefore more likely to be annuals here than perennials, for it is only those which have some special contrivance for water reserve that are able to withstand the hot dry season. The balance between conditions which produce annuals and those which produce perennials is, however, apparently slight. Upon low desert mesas may be found shrubs and annual plants almost entirely, while in the foothills, at slightly higher elevations, perennials and shallow-rooted plants, such as grasses, are abundant, although seldom producing even the semblance of a sod. The soil conditions are also decidedly different in the sodded and unsodded regions, which, without doubt, has a marked influence upon the nature of the turf. In the unsodded areas the soil is much younger, generally coarser, and lacking in humus.

BURNING NATIVE PASTURES.

There are certain regions where the burning of native pastures at regular intervals has been practiced for many years with apparently little injury. Indeed, there appears to be but little question that

this practice has been beneficial in some instances, though it would be most unfortunate in the present range regions. In some of the Eastern and Southern States, especially where the brome sedges (*Andropogon* spp.) are an important factor in the vegetation of old, permanent, and native pastures, it is doubtful whether any other method of handling would prove as productive. These grasses produce strong, wiry, branching culms in late summer, which if left unburned or uncut would make it nearly impossible for stock to secure the young growth in the spring, while the growth of the previous year is of no value.

As far west as central Kansas it is a common practice to burn pastures periodically. So far west, however, this practice is very questionable because of the large numbers of other grasses which are injured by such treatment. The gramas (*Boutelona* spp.), which are an important constituent of native pastures, from the eastern line of the Dakotas westward especially, are very readily injured by burning, especially when the ground is dry, as it usually is in autumn in this region. It is a matter of common observation that native pastures where this practice obtains which have been repeatedly burned are very much reduced in the quantity of blue grama (*Boutelona oligostachya*) which they produce, while the broom sedges (*Andropogon* spp.) produce as well as ever unless the pastures have been much overstocked. When burning is practiced it should be done when the ground is moist or frozen, so that as little injury as possible may be done to the roots of the grasses. The practice is a necessary evil at best. Mowing should be resorted to in removing the old dead stems of the species of Andropogon in preference to burning whenever it is possible.

The burning of native pastures has no application to the general open range country.

CULTIVATION.

Considerable has been written concerning the beneficial effects of cultivation upon native pastures, but the practice has no application except upon small pastures in productive regions. A pasture requiring 20 acres to support a mature bovine animal for one year can not be profitably given even a light cultivation. Whether lands are benefited by a light harrowing or disking depends entirely upon the nature of the soil and the grasses composing the native vegetation. Loosening the soil lightly with a disk or fine-tooth harrow has been proved to be beneficial in the prairie States of South Dakota, Kansas, and Nebraska, and in other States farther east. Upon unsodded territory in Arizona, where the Department of Agriculture in cooperation with the Territorial University has experimented for several years along this line, disking has proved actually detrimental. A large part

of the sparse perennial vegetation was destroyed by the disking, and this effect was noticeable for about two years. The plants which escaped killing by the disk were larger than common, but there was really less feed produced the succeeding season than on uncultivated lands adjoining. The use of a fine-tooth harrow on these lands produced a slightly increased yield, but not enough by any means to pay for the labor. The fine-tooth harrow loosened the soil slightly without destroying the vegetation.

In a large section of the prairie region, from the Dakotas southward, ground allowed to run back before the sod has been thoroughly subdued invariably comes up to a very greatly increased stand of western wheat-grass (*Agropyron occidentale*) without any seed being sown. Disking here always produces increased yields of grass, and the pastures being small and productive, the increase will compensate for the expense. Some experiments conducted by the Kansas Agricultural Experiment Station show conclusively the benefits to be derived from the cultivation of native pastures in the vicinity of Manhattan.

Mr. W. J. Tod broke a 60-acre piece of prairie of raw blue-joint (*Andropogon* sp.) in March, 1884. That same season he took off a small crop of millet. In the autumn the ground was back-set and seeded to clover, timothy, bluegrasses, and orchard grasses. It is well known that breaking land in March in this region does not kill native grasses well. The result was that although the tame grasses supplemented the native feeds for a number of years—and persist even yet—it was the native grasses that were especially improved by the cultivation. It is estimated that this area has produced ever since an average increase of 50 per cent in forage over the untouched land surrounding, and people who put up hay for hire in the vicinity are willing to harvest this area for 25 cents a ton less than the surrounding country. But this region is productive. The land will support continuously and maintain its productiveness at the rate of one bovine animal to 4 acres for the summer grazing season. Here grazing is carried on during the summer season only, for the grasses do not cure well on account of the fall rains. In such a region the cultivation of lands held in native pasture can be made profitable. Indeed, a gain of 50 per cent can often be made, but, as stated, when the carrying capacity is low partial cultivation will not pay.

In a large part of the range region cultivation is actually impossible owing to the roughness or stony character of the country. In some sections the soils are so sandy that loosening them would cause drifting. Again, in some mountain meadow regions the soil is of such a nature that it is likely to be washed badly when once the surface is disturbed.

WEEDS IN NATIVE PASTURES.

In connection with native pastures the term weed is of very uncertain meaning, for what is considered a weed in one section is often a valuable forage plant in another. It is a common saying upon the stock ranges that a steer will eat what he is obliged to eat. As an illustration may be mentioned the Mexican poppy (*Eschscholtzia mexicana*) of the Southwest. This would scarcely be considered a forage plant of any value whatever by one unfamiliar with southwestern conditions. However, one can not but be impressed with the amount of feeding done upon it by stock in southern Arizona. In the vicinity of a large inclosure in the Santa Rita Mountains this plant is grazed to the ground by cattle, while it grows to a foot or more in height in the protected area and can be recognized within this area by the brilliant color of its bloom thirty miles away. It would ordinarily be considered of some value as a sheep feed, but it is not a weed in relation to cattle by any means.

In productive native pastures of the Middle West or the central plains region certain plants, mainly of the golden-rod and sunflower families, often become quite troublesome in overgrazed areas. In the North these are represented by the golden-rod (*Solidago rigida*); farther south by several species of golden-rod and sunflower; and from Oklahoma southward into southern Texas by the broom-weed (*Amphiachyris dracunculoides*). These plants assist in the demands made for burning pastures in some sections spoken of elsewhere; but a more effectual way of handling them is to mow them when in early bloom. This is extensively practiced in Kansas and Nebraska with good results. The plants here mentioned, which stock will not eat, are all natives which become troublesome under the artificial conditions brought about by handling stock upon native lands. There are but few introduced weeds which are common upon the stock ranges that are decidedly injurious. The brome-grasses, alfilerilla, wild oats, and others have been mentioned as being of decided value. Even the Russian thistle (*Salsola kali-tragus*), originally introduced into the prairie region where it never becomes troublesome in native pastures, is spreading in northern New Mexico and Arizona, but it is of some value upon these desert lands. In mountain regions there are several perennial weeds which do considerable damage and appear to increase with constant grazing. As examples may be mentioned dandelion (*Taraxacum* sp.), false hellebore (*Veratrum* sp.), yarrow (*Achillea* sp.), flag (*Iris* sp.), and *Wyethia* sp. Even some of these are of some value as sheep feed. These all grow in mountain pastures and high valleys. Some of them can be handled by breaking up the ground and sowing to timothy and redtop. Others grow on lands which can not be cultivated, and it is doubtful whether they can

be reduced by any practicable economic methods. On the edges of mountain meadows where the moisture is sufficient cultivation can be applied with economic benefit where the lands are under private control.

To be brief, what can be done depends upon the locality and the conditions. In favored localities it will pay to resort to some of the methods mentioned in the preceding pages. Where the carrying capacity of the lands is low no methods of eradication of weeds will pay for the labor involved. All that can be done is to get out of the land all that it produces of valuable plants without the abuse of overgrazing and to utilize the weeds if it can be done, if not by cattle then possibly by sheep or goats. It must be borne in mind that the really troublesome range weeds are few in number and locally distributed and that a large percentage of the feed upon the stock ranges to-day is produced by weeds.

SUMMARY.

(1) The introduced forage plants which have thus far become important upon range pastures in this country are few in number and without exception accidental in introduction.

(2) Profitable partial cultivation of native pastures must be confined to productive areas in regions of sufficient rainfall to permit at least the occasional cultivation of some of the hardier crops.

(3) The areas where reseeding methods on an economic basis are applicable extend to the western plains and are scattered throughout the mountains in meadows, high valleys, and other situations where the requisite moisture occurs.

(4) Care should be exercised in the cultivation of moist mountain meadows lest the breaking of the turf should result in destructive erosion.

(5) The most promising forage plants for the improvement of native pastures are Kentucky bluegrass as far west as the western plains region and as far south as the Bermuda and Johnson grass lands, and timothy and redtop for mountain meadows, high valleys, and other favorable situations having a loose friable soil containing a good supply of humus. Red, white, and alsike clovers and orchard grass are of value locally. These can be established with a minimum of cultivation. Seed may be sown either in late autumn or as the snow goes off in the spring.

PLATES.

DESCRIPTION OF PLATES.

PLATE I. Improved and unimproved native meadows in northeastern California. Fig. 1.—Timothy and redtop established without cultivation in one of the high valleys of northeastern California. Fig. 2.—An unimproved valley similar to that shown in figure 1. If the willows were cleared off and timothy and redtop sown they would take possession up to the sagebrush shown in the foreground.

PLATE II. Central California ranges. Fig. 1.—A sedgy, weedy mountain meadow where timothy and redtop will succeed, but the turf must not be destroyed, for erosion would completely drain the meadow. Fig. 2.—Foothills where introduced brome-grasses have taken possession. Some of these are valuable; others are really an injury to the range.

PLATE III. Native pastures in Kansas and Arizona. Fig. 1.—A native pasture in central Kansas where Kentucky bluegrass is gradually taking possession. It appears first in such draws and depressions as are shown in this illustration. Fig. 2.—A native pasture in Arizona during a favorable season. Mexican poppy and Indian wheat make a good growth. Alfilerilla is spreading here gradually of its own accord. Experiments thus far have failed to produce economic results here.

FIG. 1.—TIMOTHY AND REDTOP ESTABLISHED WITHOUT CULTIVATION.

FIG. 2.—AN UNIMPROVED VALLEY SIMILAR TO THAT SHOWN IN FIGURE 1.

IMPROVED AND UNIMPROVED NATIVE MEADOWS IN NORTHEASTERN CALIFORNIA.

FIG. 1.—A SEDGY, WEEDY MOUNTAIN MEADOW WHERE TIMOTHY AND REDTOP WILL SUCCEED.

FIG. 2.—FOOTHILLS WHERE INTRODUCED BROME-GRASSES HAVE TAKEN POSSESSION.

CENTRAL CALIFORNIA RANGES.

FIG. 1.—A NATIVE PASTURE IN CENTRAL KANSAS WHERE KENTUCKY BLUEGRASS IS GRADUALLY TAKING POSSESSION.

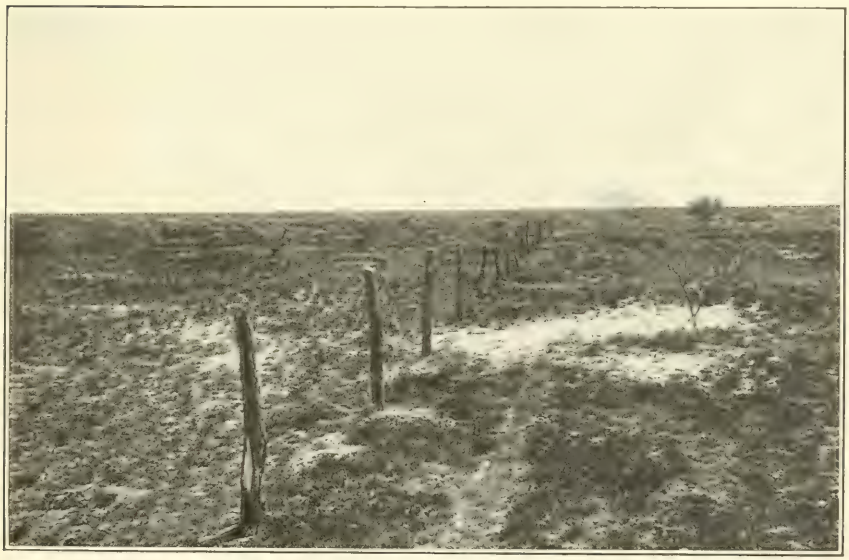


FIG. 2.—A NATIVE PASTURE IN ARIZONA DURING A FAVORABLE SEASON.

NATIVE PASTURES IN KANSAS AND ARIZONA.

INDEX.

Page.

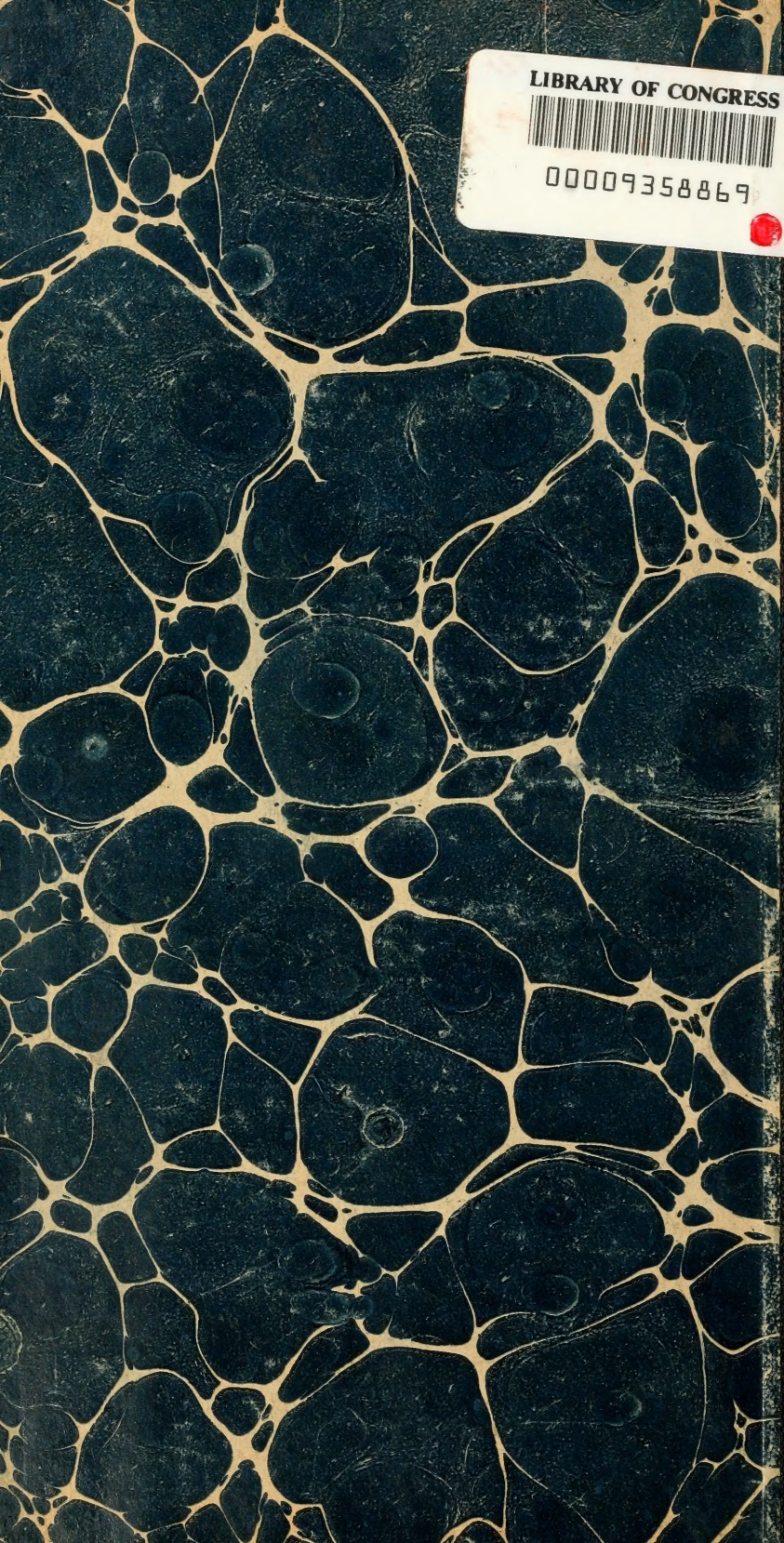
Achillea sp., troublesome weed in pastures, control 21–22
Agriculture, Department, work in reseeding depleted ranges and pastures .. 8, 11, 13
Agropyron occidentale, use on Black Hills, South Dakota 9, 20
spicatum, use on denuded pastures, eastern Washington 10
Agrostis alba. *See* Redtop.
Alfilerilla, introduction, climate adaptation, and spread 15–16, 18
Amphiachyris drachunculoides, troublesome weed in pastures, control 21
Andropogon spp., effect of burning pastures 19
Arizona, alfilerilla, use and spread 15–16
Avena spp., use for pasture in California and Arizona 16
Bermuda grass, establishment in pastures, Southwestern States 17
Blue joint, cultivation, beneficial effects 20
Bouteloua oligostachya, injury by burning pastures 19
Brome-grasses, use as pasture on Pacific coast, injurious qualities 16
sedges, effect of burning pastures 19
Bromus maximus, injurious to sheep 16
spp., abundance on Pacific coast, injurious to stock interests 16
Broom weed, troublesome in pastures, control 21
Bunch grass, use on denuded pastures, eastern Washington 10
Burning native pastures 18–19
California, alfilerilla, use and spread 15
use of wild oats and brome-grasses 16
Clover, red and white, use on mountain meadows 12
Cultivation, pasture, beneficial effects 19–20
Cynodon dactylon, establishment in pastures in Southwestern States 17
Dandelion, troublesome weed in pastures, control 21–22
Disking pastures, injurious effects on unsodded ground 20
western wheat-grass, beneficial effects 20
Elymus condensatus, use for pasture, seed habits, and quality 10–11
triticoides, use in California valleys, seed habits, and spread 10
Erosion of mountain lands, danger in cultivation of meadows 13, 20
Eschscholtzia mexicana, use for pasture in Southwest 21
Experiment stations, State, work in reseeding depleted ranges and pastures ... 8, 20
Fall planting of pasture lands, methods and advantages 12, 14
Flag, troublesome weed in pastures, control 21–22
Golden-rod, troublesome weed in pastures, control 21
Grama, blue, injury by burning pastures 19
Grass, blue joint, cultivation, beneficial effects 20
bunch, use on denuded pastures, eastern Washington 10
giant rye, use for pasture lands, seed habits, and quality 10–11
orchard, use on mountain meadows 12
western wheat, use in Black Hills, South Dakota 9–10, 20

Page.
Grasses, cultivated species, use in improving meadows and pastures 11–15
native species, use in reseeding depleted pastures 8–11
perennial, difficulty of securing seed 8–9
seed, distribution by Department of Agriculture 8
Harrowing native pastures, effects 19–20
Hellebore, false, troublesome weed in pastures, control 21–22
Hordeum murinum, value as hay, injurious qualities 16–17
Introduction to bulletin 7
Iris sp., troublesome weed in pastures, control 21–22
Johnson grass, establishment in pastures in Southwestern States 17
Kansas Agricultural Experiment Station, experiments in cultivating native pastures 20
Kentucky bluegrass, value for pasture and spread into western regions 14–15, 17
Meadows, mountain, use of clovers and orchard grass 12
value of redtop and timothy 11, 12–13, 22
Montana, use of redtop and timothy on mountain meadows 11
Mountain meadows, use of clovers and orchard grass 12
value of redtop and timothy 11, 12–13, 22
Mowing, advantage over burning pastures 19
Oats, wild, use for pasture in California and Arizona 16
Orchard grass, use on mountain meadows 12
Oregon, use of redtop on mountain meadows 11
Pastures, cultivation, beneficial effects 19–20
native, burning 18–19
reseeding with native species 8–11
cultivated species 11–15
Perennial grasses, difficulty of gathering seed 9
Phleum pratense. *See* Timothy.
Plates, description 24
Plowing mountain meadows, danger of erosion 13, 20
Poa pratensis, value for pasture, spread into western plains region 14–15
Poppy, Mexican, use for pasture in Southwest 21
Range reseeding, popular conceptions 7–8
Redtop, adaptation to moist situations 12, 13
use in sinks above alkaline soils under irrigation 11
value and adaptation to mountain meadows 11, 12–13, 22
Reseeding ranges, popular conceptions 7–8
Results accomplished with native species 8–11
cultivated species 11–15
introduced weedy species 15–17
Russian thistle, use for pasture, injurious qualities 17, 21
Rye-grass, giant, seed habits, quality, and use for pasture lands 10–11
Salsola kali-tragus, use for pasture, injurious qualities 17, 21
Seed, grasses, distribution by Department of Agriculture 8
perennial grasses, difficulty of securing 9
Seeding, character dependent upon nature of region 17–18
grass on snow in mountain meadows 12
Sheep grazing, means of spreading alfilerilla 16
injuries from pasturing on Bromus maximus, or tucolote 16
Sinks above alkaline soils, use of redtop and timothy under irrigation 11
Solidago rigida, troublesome weed in pastures, control 21
Sorghum halapense, establishment in pastures in Southwestern States 17

Page.
South Dakota, use of western wheat-grass in Black Hills 9–10, 20
Spring seeding of mountain meadows 12
Summary of bulletin 22
Taraxacum sp., troublesome weed in pastures, control 21
Thistle, Russian 17, 21
Timothy on willow lands in Okonogan Valley, Washington 13
use in sinks above alkaline soils under irrigation 11
value and adaptation to mountain meadows 11, 12–13, 22
Tucolote, injurious to sheep 16
Veratrum sp., troublesome weed in pastures, control 21–22
Wall-barley, value as hay and injurious qualities 16–17
Washington, eastern, use of bunch-grass on denuded pastures 10
Okonogan Valley, use of timothy on willow lands 13
Weeds in native pastures, use as feed 21–22
troublesome in pastures, methods of control 21–22
Weedy species of forage plants, introduction and spread 15–17, 18
Wheat-grass, western, use on Black Hills, South Dakota 9–10, 20
Willow lands, adaptation to timothy 12–13
Wyoming, timothy pastures, yield 11
Wyethia sp., troublesome weed in pastures, control 21–22
Yarrow, troublesome weed in pastures, control 21–22

117

O


LIBRARY OF CONGRESS
00009358869